Effects of a Social-Network Method for Group Assignment Strategies on Peer-Led Tobacco Prevention Programs in Schools

Thomas W. Valente, PhD, Beth R. Hoffman, MPH, Annamara Ritt-Olson, MA, Kara Lichtman, MA, and C. Anderson Johnson, PhD

Objectives. Our study tested the effectiveness of network methods for identifying opinion leaders and for constructing groups.

Methods. Three conditions—random, teacher, and network—were randomly assigned to 84 6th-grade classrooms within 16 schools. Pre- and postcurriculum data on mediators of tobacco use were collected from 1961 students. Peer leaders in the network condition were identified by student nominations, and those leaders were matched with the students who nominated them.

Results. Students in the network condition relative to the random condition liked the prevention program more and had improved attitudes ($\beta = -0.06$; $P < .01$), improved self-efficacy ($\beta = -0.10$; $P < .001$), and decreased intention to smoke (adjusted odds ratio [OR] = 0.46; 95% confidence interval [CI] = 0.38, 0.55).

Conclusions. The network method was the most effective way to structure the program. Future programs may refine this technique and use it in other settings. (*Am J Public Health.* 2003;93:1837–1843)

Smoking is the single most preventable cause of premature death and disability in the United States.[1] An estimated 430 000 deaths are attributed to cigarette smoking each year. School-based smoking and substance use prevention programs have been created to reduce this burden.[2–9] Several reviews have shown that school-based programs can reduce tobacco use by 25% to 50%.[10–15] Although most school-based tobacco prevention programs are based on a social-influences model, they have not been structured to take full advantage of the possible positive aspects of peer influence.

One way to include social influences in school-based tobacco prevention programs is by using peer leaders. Peer-led interactive programs are hypothesized to be more effective than teacher-led programs and more effective when compared with controls. Meta-analyses of substance use prevention programs have shown that interactive programs—those that incorporate student-to-student exercises—are more effective than lecture-style programs.[11,14] Current guidelines for implementing school-based tobacco prevention programs recommend the use of peer leaders,[16] and a number of studies have found peer leaders to be effective implementers of tobacco prevention[17–22] and health promotion programs.[23–26]

There is, however, considerable variation in how peer leaders are selected. Peer leaders for middle school programs have varied from college students[17,19] to high school students[27] to students of the same age.[22,28,29] In some cases peer leaders are self-selected, and in other cases student nominations are used to identify same-age peer leaders.[17,28,30–32] All of the school-based tobacco prevention programs that used peer leaders reported some success in reducing smoking or changing mediators.

Although this evidence suggests that peer leaders are important components of health promotion programs, there have been no studies to evaluate how these leaders should be assigned to groups. In classroom settings, teachers often have students work in groups, because evidence shows that this approach improves learning. Rottier and Ogan reviewed several studies on group learning in middle and junior high schools and concluded that group learning encourages higher achievement (especially for average and below-average students), promotes better reasoning skills, fosters positive relationships among students, increases positive feelings toward the subject matter, and results in higher self-esteem.[33] A meta-analysis of 122 studies indicated that group learning promotes higher achievement than do individual- and competitive-learning experiences,[34] and this effect held across all ages, academic subjects, and types of learning tasks.[35–38]

Randomization is the most common method for constructing groups in classrooms. Typically, teachers ask students to count to a certain number, and students are assigned to groups with the same number. Randomization has numerous advantages, including ease of implementation, control of teacher and student biases, and objectivity. In many classrooms, teachers assign students to groups on the basis of the teachers' knowledge of who works well with whom. Assigning students in tobacco prevention and most health promotion programs to groups on the basis of different abilities may be impractical, because it requires pairing students who engage in a behavior (smoking) with those who do not, which raises ethical concerns.

We tested the effectiveness of peer leader selection strategies and group creation within a school-based tobacco prevention program. Three conditions were compared: (1) *random*—leaders defined as those who received the most nominations by students, and groups created by randomly assigning students to leaders; (2) *teacher*—leaders and groups created by teachers; and (3) *network*—leaders defined as those who received the most nominations by students, and groups created by assigning students to the leaders they nominated.

The rationale for the network condition came from research on the effects of social-network influences on tobacco use[39–48] and other health behaviors.[49–52] It has been shown that peers influence tobacco use; therefore, teaching resistance skills within the context of these peer relationships is a promising approach. The network condition identifies opinion leaders through peer nominations, and it extends the logic of peer

influences by matching students with the leaders that the students nominated—leaders who are 1 step (the student is assigned to a leader that the student nominated) or 2 steps (the student is assigned to a leader who was nominated by one of the student's nominees) away. In this manner, students are assigned to the leaders they nominated, which recognizes that opinion leadership is a localized phenomenon—opinion leaders are not leaders for everyone; rather, they are leaders for those who nominate them to be leaders.[53]

The 3 conditions—random, teacher, and network—each have obvious advantages and disadvantages. The random condition capitalizes on student opinions and is unbiased, but it requires the collection of network data. The teacher condition is simple to implement, because it relies on the teachers' knowledge, but it is dependent on that knowledge alone. The network condition capitalizes on student opinions but also requires collection of network data. In addition, it requires using a computer algorithm to match the leaders with the groups. The cost of the network condition can be offset by several advantages: (1) students learn to practice resistance skills with their near peers who probably will be present in situations where smoking will occur; (2) the group process can be amplified, because students become more engaged with the curriculum; (3) curriculum lessons may continue outside the classroom, when students discuss the lessons with their friends; and (4) students may learn more if they are in a comfortable social setting with their friends. Thus, comparing the effectiveness of these conditions has important programmatic (how to implement programs in the future) and theoretical (how do programs work) implications.[54]

Our study presents preliminary results from a school-based tobacco use prevention program implemented in the sixth-grade, the first year of middle school. Most of the students were aged 11 or 12 years. These ages and the corresponding grade level have been identified with the onset of smoking.[2] Two programs, a general social-influences program and a culturally tailored program, were implemented, and schools receiving these programs were compared with control schools that did not receive a specific tobacco use prevention intervention. Both programs use a social influence–based smoking-prevention curriculum for sixth-grade students, consist of 8 50-minute sessions, and include an initial session for peer leader training. Trained college-aged health educators teach the programs, usually with the regular classroom teacher in attendance. The curriculum includes Socratic discussions, role-playing, and games, and the classroom sessions take place once a week for 8 consecutive weeks. Before the programs start, peer leaders are taught how to organize their groups, how to communicate with the students, how to provide positive feedback, and how to encourage cooperation. Peer leaders distribute materials, collect materials, lead discussions, and organize group activities.

In both programs, students work with their groups during every session and are asked to work on a group project outside of class. The group project—students perform skits with their assigned groups during the last session—is the culminating event of both programs. The students are given time during class to create their skits and are encouraged to work during lunchtime and after school. Both programs aim to change psychosocial mediators of tobacco use, such as attitudes toward smoking, self-efficacy, refusal skills, coping skills, and intention to smoke. Because many of the activities take place in groups, the composition of groups and the selection of leaders may be critical elements that determine program effectiveness.

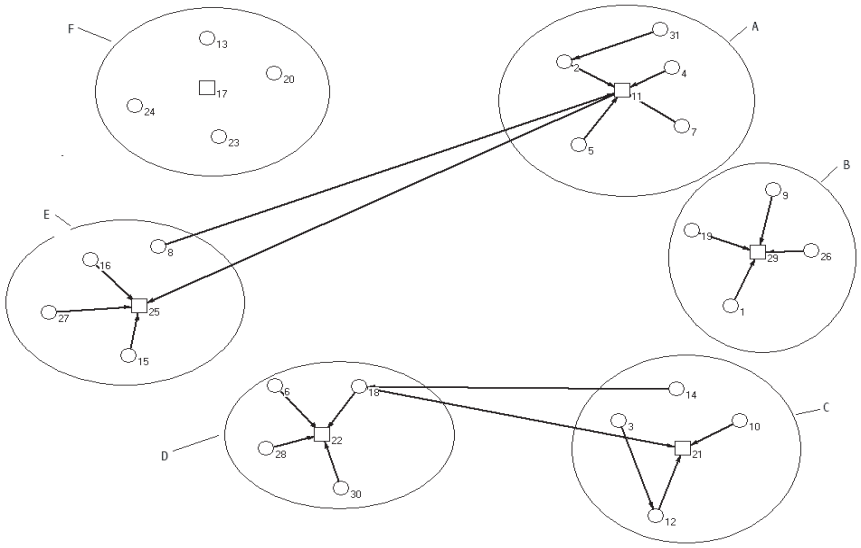
METHODS

Our study was nested within a larger trial that was evaluating 2 social-influence programs for smoking prevention—a universal program and a culturally tailored program—in 16 middle schools in Los Angeles County, Calif. The student population in each school either had a majority of Hispanic/Latino students or had no single ethnicity in the majority but at least 35% of the student body was Hispanic/Latino or Asian American. The programs were implemented in sixth-grade classrooms during April and May 2001. An analysis that compared participating schools with schools that declined to participate because of district or supervisor refusal or because of low consent rates showed no significant differences in ethnic composition, scholastic achievement, and socioeconomic status. The 84 classes in the 16 schools were randomly assigned to 1 of the 3 study conditions: random, teacher, or network (Table 1). Our study compared 3 group-formation techniques (random, teacher-assigned, and network/peer-assigned) that were implemented at the classroom level and were nested within a comparison of 2 tobacco prevention programs.

We administered 3 surveys: a baseline survey that measured ethnicity, smoking behavior, and other variables (January 2001); a precurriculum survey that measured attitudes and intentions (March 2001); and an identical postcurriculum survey that measured attitudes, intentions, and curriculum appeal (June 2001). Of the 2775 eligible students, 2278 (82.1%) completed the baseline survey, and 2105 (75.8%) completed the pre- and postcurriculum surveys. Because of different consent requirements, only 1539 (67.6%) of those who completed the curriculum survey also completed the baseline survey. Of the 2105 curriculum respondents, 144 (6.8%) did not answer all of the survey items and were omitted from our analysis. The final sample contained 1961 students (70.7%), 1444 (73.6%) of whom had additional baseline data on ethnicity and smoking behavior.

TABLE 1—Schools, Classes, and Students Randomly Assigned to the Random, Teacher, and Network Study Conditions

	Universal Curriculum			Culturally Tailored Curriculum			Total
Schools, No.	8			8			16
Network condition	Random	Teacher	Network	Random	Teacher	Network	
Classes, No.	14	12	12	16	16	14	84
Students, No.	359	281	311	363	349	298	1961



Note. One hundred nineteen links are not shown because they did not result in group assignments.

FIGURE 1—Group assignments for 1 class.

Network Conditions

Peer leader data were collected by instructing students, "Think about the 5 people in this class who would make the best leaders for working on group projects. Write up to 5 names on the lines below, starting with the best leader on the first line." Students also were instructed to write numbers from a class roster next to the names to facilitate data entry. These data constituted a social network of peer leader nominations.[49,55–58]

Classrooms were divided into 6 groups. The random condition was created by selecting students who received the most nominations by peers to be leaders and then randomly assigning students to each of those leaders. The teacher condition was created by having all teachers complete a worksheet that identified leaders and group members. The network condition was created by selecting students who received the most nominations to be peer leaders. Students then were assigned to the leaders they chose or, if they were not directly connected to a leader, were assigned to the leader to which they were connected indirectly (algorithm available from the authors).

Figure 1 shows group assignments for 1 class in the network condition. Leaders (students 11, 29, 21, 22, 25, and 17) are depicted as squares, and group members are depicted as circles with arrows that indicate nomination as a peer leader. Most students were assigned to a leader they nominated. For example, students 2, 4, 5, and 7 were assigned to leader 11 in group A. Four students were 2 steps away from their leader (students 3, 8, 14, and 31), and 4 were not at all connected to their leader (all in group F). Student 8 was assigned to leader 25 rather than to leader 11, because groups were first constructed of equal size before any remaining students (student 31) were assigned. There were an additional 119 leader nominations (31 students multiplied by an average of 4.58 leader nominations minus the 23 shown) that are not shown for clarity.

As a manipulation check, the average distance between students and their assigned peer leaders was compared. As expected, the network condition had statistically significant shorter distances (1.83 steps [SD=1.78]) than did the teacher and random conditions (2.49 steps [SD=1.78] and 2.55 steps [SD=2.04], respectively).

Analysis Plan

We first determined whether program appeal varied by condition and then whether attitudes and intention to smoke varied by condition. We repeated the analysis at the classroom level. The random condition was treated as the referent. The effects of peer leader selection might not be independent of the culturally tailored program, thus our analysis included a dummy variable for the culturally tailored program and interaction terms for the teacher and network conditions and this program. Control variables included gender, ethnicity, smoking, and school smoking prevalence. All analyses controlled for clustering within schools.

School-based interventions were usually assigned at the school level rather than the classroom level to reduce contamination between conditions.[59,60] Because contamination of the peer leader condition was not a concern, classroom-level assignment was possible. In all classes, both student nominations and teacher assignment data were collected, so that the students, teachers, and health educators would have no indication of the conditions imposed. In some schools, different classes were assigned to different peer leader conditions to enable comparisons within those schools.

RESULTS

Table 2 shows sample characteristics from the baseline survey. There was an equal number of boys and girls (50.0%), and most students were aged 11 years (70.2%) or 12 years (28%). The majority had at least 1 foreign-born parent (74.4%), and many had at least 1 parent who was a college graduate (42.4%). A majority of the sample was Hispanic or Latino (54.4%), and a significant percentage was Asian American (23.4%). Few had ever tried a cigarette (9.0%), and fewer still had ever smoked a whole cigarette (2.1%). Intention to smoke was 11.9%. These smoking rates are consistent with estimates in other surveys.[61,62] Table 2 also shows that students in the baseline sample were similar to those who completed the baseline and curriculum surveys (n=1444).

Factor analysis of the 24 program appeal items (available from the authors) returned 3 factors with eigenvalues greater than 1. The factors were labeled leader/group appeal (α=.89), friend support (α=.79), and cur-

TABLE 2—Demographic Characteristics of Baseline Sample and of Students Who Completed Baseline and Curriculum Surveys

	Baseline Data (n = 2278), %	Baseline and Curriculum Data (n = 1444), %
Male	50.0	52.6
Aged 11 years	70.2	68.3
1 parent foreign born	74.4	77.2
1 parent college graduate	42.2	40.5
Hispanic/Latino	54.4	55.7
Asian American	23.4	25.4
Ever tried cigarette	9.0	9.4
Ever tried whole cigarette	2.1	1.8
Intend to smoke	11.9	11.7

riculum appeal (α=.81). Leader/group appeal items measured specific aspects of the leaders and the groups formed during the program. Friend support measured the degree of social support for nonsmoking norms, and curriculum appeal measured generic aspects of the prevention programs. Table 3 shows regression results indicating that both the teacher condition (β=–0.07; $P<.01$) and the network condition (β=–0.14; $P<.001$) were significantly associated with greater leader/group appeal. The network condition also was associated with higher perceptions of friend support for nonsmoking (β=–0.09; $P<.001$), and neither condition was associated with curriculum appeal.

Factor analysis of the 31 attitude items (available from the authors) returned 3 factors with eigenvalues greater than 1. Factor analysis results were similar in the pre- and posttest data. The factors were labeled smoking attitude (α=.90), self-efficacy (α=.67), and social consequences (α=.56). (Conceptually, we expected the smoking attitude items to form 3 subscales—general attitudes, health as a value, and resistance skills—but this was not the case.) Table 4 shows regression results for posttest attitude and intention-to-smoke variables. The teacher condition did not change attitudes. Relative to the random condition, the network condition was associated with improved attitudes (β=–0.06; $P<.01$) and improved self-efficacy (β=–0.10; $P<.001$) but not with improved perceived social consequences β=0.02, $P=.64$. The network condition also was associated with decreased intention to smoke (OR=0.46; 95% CI=0.38, 0.55), which indicated a 54% lower level of smoking intentions relative to the random condition. There was a significant condition-by-program interaction such that students in the network condition who received the culturally tailored curriculum reported higher intention to smoke (OR=1.93; 95% CI=1.20, 3.12). This interaction effect decreased to nonsignificance when the analysis was restricted to the subsample of students who completed both the baseline and curriculum surveys.

Because students are clustered in schools and classrooms, it is possible that these results are inflated by the nonindependence of observations, although the regression controlled for intraschool clustering.[59] Scores were aggregated to the classroom level by calculating classroom means on all variables and by repeating the analysis (n=84). Table 5 shows that the classroom-level results are consistent with the individual-level analysis. The teacher condition did not change attitudes. The network condition improved attitudes (β=–0.16; $P<.05$) and self-efficacy (β=–0.34; $P<.001$) but did not improve perceived social consequences (β=–0.11; $P=.51$). The network condition also was associated with decreased intention to smoke (β=–0.31; $P<.05$) and, similar to the individual-level analysis, with greater program appeal (results not shown).

TABLE 3—Effects (ß Coefficients) of Demographic, Smoking, and Study Condition Variables on 3 Scales Measuring Leader/Group Appeal, Friend Support for Antismoking Norms, and Curriculum Appeal (n = 1961)

	Leader/Group Appeal	Friend Support	Curriculum Appeal
Male	0.14**	0.17***	0.12***
Smoking prevalence	0.11**	0.13**	–0.03
Hispanic/Latino	–0.02	0.01	–0.06
Asian American	0.03	–0.01	0.04
Ever puffed a cigarette	0.07*	0.04	0.03
Baseline data only	–0.05	–0.06*	–0.03
Tailored curriculum	–0.01	0.00	0.01
Teacher condition	–0.07*	–0.04	–0.06
Network condition	–0.14**	–0.09**	–0.05
Teacher condition × tailored curriculum	–0.01	0.02	–0.01
Network condition × tailored curriculum	0.04	0.06	–0.01
R^2	5%	6%	3%

Note. Regression controls for intraschool covariation.
*$P<.05$; **$P<.01$; ***$P<.001$.

DISCUSSION

Although the results reported here are positive, notes of caution are warranted. First, we report short-term results that represent 2 to 3 months between surveys. Second, the outcomes measured are attitudinal mediators and are not behaviors, and it remains to be seen whether behaviors will be affected. These attitudinal mediators, however, have been shown to be strongly associated with later smoking initiation.[63] Our results are strongest for intention to smoke, which has been validated as a predictor of smoking in other studies.[64,65] A third limitation is reporting bias. Because friends may choose the same leader and then be grouped together, they might report more positive outcomes. As a result, their friendship groups might appear to perform better. Finally, there was a network condition-by-program interaction on intention to smoke such that scores were slightly worse in the schools that received the

TABLE 4—Effects (ß Coefficients) of Demographic, Smoking, and Study Condition Variables on Nonsmoking Attitudes, Self-Efficacy, Social Consequences of Smoking, and Intention to Smoke After Control for Precurriculum Levels (n = 1961)

	Smoking Attitude	Self-Efficacy	Social Consequences	Intention to Smoke (Adjusted Odds Ratio)
Baseline score	0.59***	0.52***	0.55***	6.57***
Male	–0.03	0.02	0.03	0.91
Smoking prevalence	0.06*	0.10*	–0.01	1.06*
Hispanic/Latino	0.02	0.03	0.00	0.81
Asian American	–0.02	–0.01	0.01	0.53**
Ever puffed a cigarette	0.07***	0.03	0.01	2.47***
Baseline data only	–0.05	–0.02	0.01	0.98
Tailored curriculum	0.04	–0.02	0.07**	1.05
Teacher condition	0.00	–0.03	0.00	1.06
Network condition	–0.06**	–0.10***	–0.02	0.46***
Teacher condition × tailored curriculum	–0.05*	0.03	0.01	0.81
Network condition × tailored curriculum	0.04	0.06	0.01	1.93**
R^2	39%	29%	32%	16%

Note. Regression controls for intraschool covariation.
*P < .05; **P < .01; ***P < .001.

TABLE 5—Classroom-Level Impact Estimates (ß Coefficients) of Demographic, Smoking, and Study Condition Variables on Average Classroom Levels of Nonsmoking Attitudes, Self-Efficacy, Social Consequences of Smoking, and Intention to Smoke After Control for Precurriculum Levels (n = 84)

	Mean Smoking Attitude	Mean Self-Efficacy	Mean Social Consequences	Intention to Smoke
Pretest class average	0.67***	0.43***	0.71***	0.40***
Male	0.03	–0.10	–0.19	–0.09
Smoking prevalence	–0.02	0.19	0.13	–0.05
Hispanic/Latino	–0.46**	0.23	–0.27*	0.18
Asian American	0.19	–0.01	–0.04	–0.21
Ever puffed a cigarette	0.15**	0.12	0.07	0.09
Baseline data only	–0.26*	–0.15	0.08	–0.14
Tailored curriculum	0.12	–0.12	0.22	0.11
Teacher condition	0.01	–0.14	–0.03	0.09
Network condition	–0.16*	–0.34***	–0.11	–0.31*
Teacher condition × tailored curriculum	–0.13	0.18	0.02	–0.16
Network condition × tailored curriculum	0.14*	0.22	0.11	0.22
R^2	72%	46%	56%	57%

Note. Regression controls for intraschool covariation.
*P < .05; **P < .01; ***P < .001.

culturally tailored curriculum in the network condition. This indicates that the network approach may be sensitive to the accompanying curriculum or health promotion program.

These cautions notwithstanding, our results represent an exciting finding that has implications for health promotion programs. The data demonstrate the value of using network information to design a health promotion program. No changes to the curriculum were made; the only modification was to ask students who they thought would make the best leader and to then assign the students to groups accordingly. Importantly, this condition was compared with the standard in school-based health promotion programs, namely, choosing leaders by popularity and constructing groups randomly. These data suggest that randomization may be a less-than-optimal way to implement health promotion programs.

The network condition may be further improved by using algorithms that were developed in location science to determine the best places to locate warehouses, hospitals, fire and police stations, and the like.[66] The network condition also might be improved by including other network information, such as friendship choices, the rank/order of such choices, or the overall structure of the network. We took a simplistic approach to determine whether network data can be used to improve group leader selection and group assignments. These results suggest that network data can be used to great advantage. Future interventions may need to investigate whether other network data should be included to optimize group assignments. For instance, students chose leaders in our study on the basis of "working on group projects." Results may have been different if leaders were chosen for their status as role models, lifestyle trendsetters, or other attributes connected to tobacco use decisions.

These data suggest that previous research regarding peer influence on the decision to smoke has implications for prevention programs, because peers can be used to change susceptibility to smoking. Although most school-based tobacco prevention programs are based on a social-influences model, few take advantage of social influences in their programming. We have shown that these social influences can be harnessed to yield positive outcomes. Future programs and research should attempt to more fully understand how and why social influences lead to tobacco use and how social influences can be used to deter such use. Interestingly, in additional analyses (not reported), we found that students who were fewer steps away from their

assigned leader had improved outcomes, regardless of study condition. (We substituted reversed distance to leader for the study condition variables [OR=0.93; 95% CI=0.90, 0.97], which indicated that each additional step closer to the chosen leader was associated with a 7% decrease in intention to smoke.)

Conversely, social influences also can lead to deviancy training. Studies of interventions that allowed peer-to-peer interaction among high-risk youth have shown that peers can reinforce negative norms and attitudes. The network condition encourages friendship groups that could create negative program effects, especially in high-risk settings.[67] Future uses of the network methodology will need to pay particular attention to this possibility. (In our study, health educators completed a checklist after each session that noted any disruptions or problems. Our analysis showed no significant difference in rate of problem behavior among conditions.) An additional consideration is whether the peer leaders chosen by students are more likely to smoke and more likely to spread this negative behavior.

Teachers may know the attitudes and behaviors of the chosen peer leaders and who is likely to spread positive or negative influences. Teacher knowledge of the students and of who works well with whom is clearly valuable. Our original expectation was that the random condition would have better outcomes than the teacher condition. This was not the case. Perhaps teachers have a global view of the classroom social structure that could be used in combination with network information for the most effective implementation of school-based health promotion programs.

Finally, it is certainly possible to include other attribute information, such as gender, ethnicity, and attitudes, to explore whether both network and personal characteristics should be considered when constructing groups. School-based instruction studies indicate that overall classroom performance is enhanced when students are grouped with people of varying ability levels. Our results indicate that such variability may be less than ideal for health promotion; however, it may be that a combination of performance or attribute variability and network data is optimal.

This study demonstrates a technique for enhancing the promotion of healthy behaviors in school, community, and/or organizational contexts. It supports the view that social networks influence behavior and that social-network analysis can be used to improve health outcomes. We hope that future applications will further the benefits that social-network analysis can provide in improving understanding of health behavior and promoting health. ■

About the Authors

Thomas W. Valente, Beth R. Hoffman, Annamara Ritt-Olson, Kara Lichtman, and C. Anderson Johnson are with the Department of Preventive Medicine, School of Medicine, University of Southern California, Alhambra, Calif.

Requests for reprints should be sent to Thomas W. Valente, PhD, Department of Preventive Medicine, School of Medicine, University of Southern California, 1000 Fremont Ave, Building A, Room 5133, Alhambra, CA 91803 (e-mail: tvalente@usc.edu).

This article was accepted April 6, 2003.

Contributors

T.W. Valente designed the intervention study and conducted the analysis. B.R. Hoffman, A. Ritt-Olson, and K. Lichtman contributed to the implementation of the study. C.A. Johnson contributed to the design of the intervention study. All authors contributed to the writing of the article.

Acknowledgments

This research was supported by National Cancer Institute grant P50 CA84735–01 and California Tobacco-Related Disease Research Program grant 7PT–7004.

We thank Rebecca Davis, Susan Ennett, Mary Ann Pentz, Jennifer Unger, and 3 anonymous reviewers for comments on earlier drafts.

Human Participant Protection

This study was approved by the institutional review board of the University of Southern California (USC 993037).

References

1. *Morbidity and Mortality Weekly Report.* Youth tobacco surveillance—United States, 1998–1999. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/ss4910a1.htm. Accessed January 15, 2002.

2. Lynch BS, Bonnie R. *Growing Up Tobacco Free: Preventing Nicotine Addiction in Children and Youths.* Washington, DC: National Academy Press; 1999.

3. Botvin GJ, Griffin K, Diaz T, Scheier L, Williams C, Epstein J. Preventing illicit drug use in adolescents: long-term follow-up data from a randomized control trial of a school population. *Addict Behav.* 2000;25:769–774.

4. Botvin GJ, Baker E, Dusenbury L, Botvin E, Diaz T. Long-term follow-up results of a randomized drug abuse prevention trial in a white middle-class population. *JAMA.* 1995;273:1106–1112.

5. Botvin GJ, Dusenbury L, Baker E, James-Ortiz S, Botvin E, Kerner J. Smoking prevention among urban minority youth: assessing effects on outcomes and mediating variables. *Health Psychol.* 1992;11:290–299.

6. Sussman S, Dent C, Stacy A, et al. Project towards no tobacco use: 1-year behavior outcomes. *Am J Public Health.* 1993;83:1245–1250.

7. Flay BR, Ryan K, Best J, et al. Are social-psychological smoking prevention programs effective? The Waterloo Study. *J Behav Med.* 1985;8:37–59.

8. Hansen WB, Graham J. Preventing alcohol, marijuana, and cigarette use among adolescents: peer pressure resistance training versus establishing conservative norms. *Prev Med.* 1991;20:414–430.

9. Donaldson SI, Graham J, Hansen W. Testing the generalizability of intervening mechanism theories: understanding the effects of adolescent drug use prevention interventions. *J Behav Med.* 1994;17:195–216.

10. Tobler N. Meta-analysis of 143 adolescent drug prevention programs: quantitative outcome results of program participants compared to a control or comparison group. *J Drug Issues.* 1986;16:537–567.

11. Tobler N. Meta-analysis of adolescent drug prevention programs: results of the 1993 meta-analysis. *NIDA Res Monogr.* 1997;170:5–69.

12. Sussman S, Dent C, Burton D, Stacy A, Flay B. *Developing School-Based Tobacco Use Prevention and Cessation Programs.* Newbury Park, Calif: Sage Publications; 1995.

13. Bruvold WH. A meta-analysis of adolescent smoking prevention programs. *Am J Public Health.* 1993;83:872–880.

14. Black DR, Tobler N, Sciacca J. Peer helping/involvement: an efficacious way to meet the challenge of reducing alcohol, tobacco, and other drug use among youth? *J School Health.* 1998;68:87–93.

15. Centers for Disease Control and Prevention. Effectiveness of school-based programs as a component of a statewide tobacco control initiative—Oregon, 1999–2000. *MMWR Morb Mortal Wkly Rep.* 2001;50:663–666.

16. *Journal of School Health.* Guidelines for school health programs to prevent tobacco use and addiction. *J School Health.* 1994;64:353–360.

17. Perry C, Telch M, Killen J, Burke A, Maccoby N. High school smoking prevention: the relative efficacy of varied treatments and instructors. *Adolescence.* 1983;71:561–566.

18. Clarke J, MacPherson B, Holmes D, Jones R. Reducing adolescent smoking: a comparison of peer-led, teacher-led, and expert interventions. *J School Health.* 1986;56:102–106.

19. Elder JP, Wildey M, de Moor C, et al. The long-term prevention of tobacco use among junior high school students: classroom and telephone interventions. *Am J Public Health.* 1993;83:1239–1244.

20. Klepp K, Halper A, Perry C. The efficacy of peer leaders in drug abuse prevention. *J School Health.* 1986;56:407–411.

21. Prince F. The relative effectiveness of peer-led

and adult-led smoking intervention program. *Adolescence.* 1995;30:187–194.

22. Telch M J, Miller L, Killen J, Cooke S, Maccoby N. Social influences approach to smoking prevention: the effects of videotape delivery with and without same-age peer leader participation. *Addict Behav.* 1990;15: 21–28.

23. Lomas J, Enkin M, Anderson G, Hanna W, Vayda E, Singer J. Opinion leaders vs audit feedback to implement practice guidelines: delivery after previous cesarean section. *JAMA.* 1991;265:2202–2207.

24. Kelly JA, St. Lawrence J, Diaz Y, et al. HIV risk behavior reduction following intervention with key opinion leaders of population: an experimental analysis. *Am J Public Health.* 1991;81:168–171.

25. Latkin C. Outreach in natural setting: the use of peer leaders for HIV prevention among injecting drug users' networks. *Public Health Rep.* 1998;113(suppl 1): 151–159.

26. Sikkema KJ, Kelly J, Winett R, et al. Outcomes of a randomized community-level HIV prevention intervention for women living in 18 low-income housing developments. *Am J Public Health.* 2000;90:57–63.

27. Bell RM, Ellickson P, Harrison E. Do drug prevention effects persist into high school? How project ALERT did with ninth graders. *Prev Med.* 1993;22: 463–483.

28. Arkin RM, Roemhild H, Johnson C, Luepker R, Murray D. The Minnesota smoking prevention program: a seventh-grade health curriculum supplement. *J School Health.* 1981;51:611–616.

29. Pentz MA, Dwyer J, MacKinnon D, et al. A multicommunity trial for primary prevention of adolescent drug abuse. *JAMA.* 1989;261:3259–3266.

30. Johnson CA, Hansen W, Collins L, Graham J. High-school smoking prevention: results of a three-year longitudinal study. *J Behav Med.* 1986;9:439–452.

31. Murray DM, Luepker R, Johnson C, Mittelmark M. The prevention of cigarette smoking in children: a comparison of four strategies. *J Appl Soc Psychol.* 1984; 14:274–288.

32. Murray DM, Richards P, Luepker R, Johnson C. The prevention of cigarette smoking in children: two- and three-year follow-up comparisons of four prevention strategies. *J Behav Med.* 1987;10:595–611.

33. Rottier J, Ogan B. *Cooperative Learning in Middle-Level Schools.* Washington, DC: National Education Association; 1991.

34. Johnson DW, Maruyama G, Johnson R, Nelson D, Skon L. Effects of cooperative, competitive and individualistic goal structures on achievement: a meta-analysis. *Psychol Bull.* 1981;89:47–62.

35. Abrami PC, Chambers B, Poulsen C, De Simone C, d'Appollonia S, Howden J. *Classroom Connections: Understanding and Using Cooperative Learning.* Toronto, Ontario: Harcourt Brace; 1995.

36. Bohlmeyer EM, Burke JP. Selecting cooperative learning techniques: a consultative strategy guide. *School Psychol Rev.* 1987;16:36–49.

37. Slavin RE. Developmental and motivational perspectives on cooperative learning. *Child Dev.* 1987;58: 1161–1167.

38. Slavin RE. *Student Team Learning: A Practical Guide to Cooperative Learning.* 3rd ed. Washington, DC: National Education Association; 1991:24.

39. Ennett ST, Bauman KE, Koch GG. Variability in cigarette smoking within and between adolescent friendship cliques. *Addict Behav.* 1994;19:295–305.

40. Ennett ST, Bauman KE. Peer group structure and adolescent cigarette smoking: a social network analysis. *J Health Soc Behav.* 1993;34:226–236.

41. Derzon JH, Lipsey MW. Predicting tobacco use to age 18: a synthesis of longitudinal research. *Addiction.* 1999;94:995–1006.

42. Alexander C, Piazza M, Mekos D, Valente TW. Peer networks and adolescent cigarette smoking: an analysis of the national longitudinal study of adolescent health. *J School Health.* 2001;29:22–30.

43. Aloise-Young P, Graham JW, Hansen WB. Peer influence on smoking initiation during early adolescence: a comparison of group members and group outsiders. *J Appl Psychol.* 1994;79:281–287.

44. Urberg KA, Degirmencioglu SM, Pilgrim C. Close friend and group influence on adolescent cigarette smoking and alcohol use. *Dev Psychol.* 1997;33: 834–844.

45. Urberg KA, Shyu SJ, Liang J. Peer influence in adolescent cigarette smoking. *Addict Behav.* 1990;15: 247–255.

46. Unger JB, Chen X. The role of social networks and media receptivity in predicting age of smoking initiation: a proportional hazards model of risk and protective factors. *Addict Behav.* 1999;24:371–381.

47. Michell L, Amos A. Girls, pecking order and smoking. *Soc Sci Med.* 1997;44:1861–1869.

48. Flay BR, Hu FB, Siddiqui O, et al. Differential influence of parental and friends' smoking on adolescent initiation and escalation of smoking. *J Health Soc Behav.* 1994;35:248–265.

49. Valente TW. *Network Models of the Diffusion of Innovations.* Cresskill, NJ: Hampton Press; 1995.

50. Valente TW, Vlahov D. Selective risk taking among needle exchange participants in Baltimore: implications for supplemental interventions. *Am J Public Health.* 2001;91:406–411.

51. Neaigus A, Friedman SR, Kottiri BJ, Des Jarlais DC. HIV risk networks and HIV transmission among injecting drug users. *Eval Program Plann.* 2001;24: 221–226.

52. Bearman PS, Jones J, Udry JR. The National Longitudinal Study of Adolescent Health: Research Design. Available at: http://www.cpc.unc.edu/projects/addhealth.html. Accessed July 25, 2001.

53. Valente TW, Davis RL. Accelerating the diffusion of innovations using opinion leaders. *Ann Am Acad Polit Soc Sci.* 1999;566:55–67.

54. Valente TW. *Evaluating Health Promotion Programs.* New York, NY: Oxford University Press; 2002.

55. Borgatti S, Everett M, Freeman L. *UCINET 5 for Windows: Software for Social Network Analysis* [computer program]. Natick, Mass: Analytic Technologies Inc; 1998.

56. Wasserman S, Faust K. *Social Networks Analysis: Methods and Applications.* Cambridge, England: Cambridge University Press; 1994.

57. Scott, J. *Social Network Analysis: A Handbook.* 2nd ed. Newbury Park, Calif: Sage Publications; 2000.

58. Batagelj V, Mrvar A. Pajek: program for large network analysis. *Connections: Offi J Int Network Soc Network Analysis.* 1998;21:47–57.

59. Graham JW, Flay BR, Johnson CA, Hansen WB, Collins LM. Group comparability: a multiattribute utility measurement approach to the use of random assignment with small numbers of aggregated units. *Eval Rev.* 1984;8:247–260.

60. Murray DM. *Design and Analysis of Group-Randomized Trials.* New York, NY: Oxford University Press; 1998.

61. Johnston LD, O'Malley PM, Bachman JG. Smoking among American teens declines some. Available at: http://www.isr.umich.edu/src/mtf/index.html. Accessed January 15, 2002.

62. Cancer Surveillance Section. *California Youth Tobacco Survey.* Sacramento, Calif: California Dept of Health Services: 1998.

63. Donaldson SI. Mediator and moderator analysis in program development. In: Sussman S, ed. *Handbook of Program Development.* Thousand Oaks, Calif: Sage Publications; 2001:470–496.

64. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Merritt RK. Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. *Health Psychol.* 1996;15:355–361.

65. Unger JB, Johnson CA, Stoddard JL, Nezami E, Chou C. Identification of adolescents at risk for smoking initiation: validation of a measure of susceptibility. *Addict Behav.* 1997;22:81–91.

66. Francis R, McGinnis L, White J. *Facility Layout and Location: An Analytical Approach.* 2nd ed. Englewood Cliffs, NJ: Prentice Hall; 1992.

67. Dishion TJ, McCord J, Poulin F. When interventions harm: peer groups and problem behavior. *Am Psychol.* 1999;54:755–764.